HANDBOOK FOR PRIORITIZING WATERSHED PROTECTION AND RESTORATION TO AID RECOVERY OF NATIVE SALMON

Ad hoc working group sponsored by Oregon State Seanator Bill Bradbury

NOVEMBER 1995

Please direct comments and inquiries to:

Dr. Willa Nehlsen
Pacific Rivers Council
921 SW Morrison, Suite 531
Portland, OR 97205
****************** 503/294-0786 ******************
fax: 503/294-1066
pacificriver@igc.apc.org

HANDBOOK FOR PRIORITIZING WATERSHED PROTECTION AND RESTORATION TO AID RECOVERY OF NATIVE SALMON

Oregon State Senate President Bill Bradbury
Willa Nehlsen, Pacific Rivers Council
T.E. Nickelson, Oregon Department of Fish and Wildlife
K. M. S. Moore, Oregon Department of Fish and Wildlife
R.M. Hughes, Oregon Chapter of the American Fisheries Society
David Heller, U. S. Forest Service
Jay Nicholas, Oregon Department of Fish and Wildlife
D. L. Bottom, Oregon Department of Fish and Wildlife
W.E. Weaver, Pacific Watershed Associates
R. L. Beschta, Oregon State University School of Forestry

November 1995

FOREWORD

Protecting and restoring watersheds is a key component to recovering salmon and other native fishes. With that goal in mind, in May 1994 Oregon State Senate President Bill Bradbury asked the Pacific Rivers Council for help in assembling a group to create a process for effective and scientifically-sound watershed protection and restoration.

There was a good deal of give and take as approximately thirty individuals were involved in the six-month process. For perhaps the first time, legislators, environmentalists and scientists worked together on a regional scale problem. The primary focus of the group was to develop a framework for prioritizing restoration work at a variety of scales--from among very large basins down to individual watersheds. Such a framework should provide a common basis from which diverse groups can develop mutually agreed-upon restoration priorities reflecting a strong scientific basis.

Credit is shared by many. Certainly Senator Bradbury is paramount. Others who participated included staff from the Regional Ecosystem Office, U.S. Forest Service, Bureau of Land Management, Environmental Protection Agency, Pacific Fishery Management Council, National Marine Fisheries Service, Oregon Department of Fish and Wildlife, Oregon Governor's Office, Oregon State University, Oregon Trout, Pacific Watershed Associates, and Pacific Rivers Council. Pacific Rivers Council coordinated the development of this handbook with funding from the Corvallis Laboratory of the U.S. Environmental Protection Agency. Sue Pierson, Ogden Professional Services, Corvallis, Oregon, provided the map for Figure 2.

The working group gratefully acknowledges the constructive reviews of Gordon Grant (U.S. Forest Service Pacific Northwest Research Station, Corvallis, Oregon), Jeffrey J. Dose (Umpqua National Forest, Roseburg, Oregon), Mary Kentula (U.S. Environmental Protection Agency, Environmental Research Laboratory, Corvallis, Oregon), George Ice (National Council of the Paper Industry for Air and Stream Improvement, Inc., Corvallis, Oregon), and Hiram Li (Oregon State University Cooperative Fishery Research Unit, Corvallis, Oregon).

This document reflects the scientific expertise of the participants in a general way, but not all participants necessarily support all elements. Moreover, it does not necessarily imply endorsement by any of the groups who generously contributed the time and expertise of their staff.

PREFACE

There is little question that we are not going to be able to do everything we want to do for salmon immediately. So how do we decide what we should do first? There are millions of federal and state dollars being spent on salmon restoration right now. That expenditure presents both a significant challenge and opportunity. The challenge is to target all these expenditures to the most important efforts first. The opportunity is to actually make a difference for salmon. We can only do that if we pay attention to the biology -- not the politics, not the agency turf, not "the money's got to be spread over the landscape" -- but rather prioritizing our efforts based on the biology of salmon, which very quickly leads us to the biology of healthy watersheds.

I asked a group of federal, state, and non-government scientists, with expertise in fisheries, watersheds, and ecosystem management, to spend about a day per month for six months developing a biologically-based prioritization system that would be applicable throughout the range of Pacific Northwest salmon. They worked hard as a full committee and as sub-committees, and the result is this workbook.

It's a realistic process that forced me to, look at salmon and watershed restoration in an entirely new way. You will find as you use the workbook that this prioritization system is as much a way of strategically thinking about healthy watersheds and salmon as it is a ranking tool. I am convinced you too will find this process useful, and I am deeply indebted to all of the scientists who helped make it possible.

Bill Bradbury

TABLE OF CONTENTS

SECTION I.
*********BACKGROUND*********

PART 1.
INTRODUCTION

This handbook offers a step-by-step approach (Figure **1)** to systematically identify those areas and activities that can best protect and restore salmon and their watersheds. It provides the basis for a logical train of reasoning by multi-disciplinary groups of experts. It can be used by watershed councils or other groups of interested citizens (with the help of scientists) and by federal, state, tribal and local natural resource managers.

Because not everyone will want to go into the same depth or have the same resources for their particular restoration program, the handbook is flexible regarding the level of use. It can be used to focus efforts and allocate resources for an area as large as the Pacific Northwest, or for smaller areas, such as river basins or watersheds. It will be especially useful to those concerned with situations involving several owners or managers.

The handbook has two objectives. 1) Identity restoration activities for immediate implementation, where limited public funds are available and there is a need to quickly identify activities that may have a high certainty of effectiveness. 2) Provide the basis for protection and restoration strategies that may be implemented over longer time periods. This handbook provides scientific principles that can be used by all watershed restoration efforts. However, this does not necessarily mean that those interested in restoration should not pursue opportunities that arise outside of the framework of this handbook--well-founded efforts also may arise from public or corporate interests in specific areas or specific types of activities.

This handbook is designed to help recover native fishes, especially anadromous salmonids, by protecting and restoring their stream ecosystems. Such an ecosystem-based approach will have a greater chance for success than a single-species approach. Therefore, it will be useful to those whose focus is restoration of salmon and aquatic biodiversity within an ecosystem context. The handbook does not address important factors such as the regulation of ocean and freshwater salmon harvest or the use and management of hatcheries; although these elements are critical in achieving salmon recovery, they were deemed outside the scope of this effort.

The handbook is divided into three sections: Section I comprises background materials, including 1) An introduction on how the handbook should be used and how it was developed; 2) A general background on protecting and restoring salmon and aquatic ecosystems that serves as the conceptual basis for this handbook; 3) Definitions of useful terms; and 4) An introduction to the prioritization process and things to consider before beginning. Section II presents 1) A framework for prioritizing areas (from large basins down to individual watersheds) for restoration work, which establishes a common set of criteria for developing biologically-based priorities among diverse groups of agencies or other users; and 2) An example of using the framework to prioritize river basins and watersheds in western Oregon. Section III provides 1) Considerations for the planning and development of individual projects at the watershed scale, and 2) A detailed discussion of how to treat and reduce upslope hazards.

PURPOSE	STEP(S) IN PROCESS
Assign priorities for limited funding for one or several states (e.g., Oregon or the Pacific Northwest)	Identify and prioritize geographic areas (Section II, Part 1, Steps 1 and 2) ↓
Assign priorities for limited funding within geographic areas of a state (e.g., Northwest Oregon)	Identify and prioritize river basins within geographic areas (repeat Section II, Part 1, Steps 1 and 2 for river basins) ↓
Assign priorities for limited funding within river basins (e.g., the Nehalem River basin)	Identify and prioritize watersheds within river basins (Section II, Part 1, Steps 1 and 3) ↓
Develop project-specific protection and restoration strategies within watersheds (e.g., the Louisignant Creek watershed)	Complete Section III, Part 1, Step 1 and/or watershed analysis. Design protection and restoration strategy (Section III, Part 1, Step 2). Or if analysis is too limited to design strategies, go to Section III, Part 1, Step 3.

Figure 1. **Overview of** steps in prioritization process.

How and Why This Handbook Was Developed

With over 300 salmon and steelhead stocks in the Pacific Northwest and California at substantial risk of extinction, several federal and state efforts involving millions of dollars have been initiated to restore salmon and their watersheds. However, there has not been a common framework for developing sound scientific priorities for where and how this restoration should take place. Out of concern for fiscal efficiency and successful restoration, Senate President Bill Bradbury asked the Pacific Rivers Council for help in convening a group of scientists and managers for the project.

Senator Bradbury charged the group with developing a scientifically-based framework for prioritizing native salmon and watershed protection and restoration activities applicable throughout the Pacific Northwest. The resulting framework was developed by a committee comprised of individuals representing many entities, including state, federal, tribal and regional resource managers; scientists; and fishing and environmental organizations. This approach provides sound scientific grounding to meet policy needs.

The committee met five times between May and October, 1994. Between committee meetings, a technical subcommittee worked to develop recommendations for committee review. This handbook is the result of all of their efforts. It has been reviewed by the committee members and peer reviewed.

PART 2.
PROTECTING AND RESTORING SALMON AND AQUATIC ECOSYSTEMS

This section describes the conceptual scientific basis for the prioritization process in this handbook. Underlined words are defined in Section I, Part 3--Definitions.

Goal and Approach

The goal of this handbook is to ***"Protect and restore native fishes by focusing on strategies that provide the greatest ecological benefits for native fishes and ecosystems (with priority given to anadromous salmonids).*** " Anadromous salmonids are of particular concern in the Pacific Northwest; these important native fishes therefore receive priority. Moreover, anadromous salmonids are widely seen as an indicator of the health of Pacific Northwest aquatic ecosystems, integrating watershed, mainstem river, estuary and ocean conditions. Returning watersheds to a condition that can support abundant native salmon will contribute to overall salmon productivity.

However, this handbook takes an ecosystem approach, not a single-species approach. This is in part because existing or likely listings of salmon species or populations under federal and state endangered species laws means that species-specific efforts already are or will be in progress. Moreover, single-species approaches are of limited value as an overall conservation strategy, because they 1) only protect the charismatic (visible and appealing) species; 2) cannot address the needs of a large number of species; and 3) tend to be reactive, coming into play only when the species is likely beyond repair (Ness and Cooper-rider, 1994). Conversely, an ecosystem. approach gives attention to entire ecosystems and thereby addresses the needs of larger numbers of species. Such an approach calls attention to problems before they are beyond repair, leading to more effective protection and restoration strategies and avoiding the "train wrecks" that can result when species are near extinction. Finally, an ecosystem approach focuses on the processes and elements that comprise ecosystem function, thereby deterring "fixes" that focus on symptoms rather than problems.

The Watershed

Because aquatic species are the focal point of this handbook, the most appropriate functional unit to consider is the watershed (Doppelt et al. 1993). An aquatic ecosystem reflects the biological, geological and hydrological processes that operate at the watershed level. The condition of an aquatic ecosystem reflects the quality of land and water management in the watershed, and most protection and restoration strategies must be implemented in the larger watershed, not just the stream channel. For many aquatic species, the watershed defines the freshwater migratory habitat (or subset of it), and is the key defining unit of habitat connectivity.

Different parts of a watershed play different roles in the life histories of salmon. Headwater tributaries are critical to the hydrological, biological and geological processes within the watershed, and serve as spawning and rearing areas for species such as coho, steelhead and cutthroat trout. Mainstem reaches provide spawning and rearing areas for species such as chinook, and are key migratory corridors for all species. Lower elevation floodplain streams tend to be the most productive rearing areas for all salmon. When one or more of these stream types in a watershed is degraded, habitat connectivity for salmon is lost, causing a decline in productivity.

Although the watershed is the key functional unit, the population dynamics of salmon and many of the processes that maintain and create their habitats operate at several spatial scales. Therefore, this handbook considers aggregates of watersheds (river basins) and aggregates of river basins (geographic areas), as well as areas within watersheds and the ecoregions that occur across watersheds and basins.

An Ecosystem Approach to Protection and Restoration

Ecological processes (such as salmon migration, energy transfer, and nutrient and water cycling) and elements (such as species assemblages and stream channel morphology) form the core of functioning landscapes (Henjum et al. 1994). Therefore, the purpose of protection and restoration as considered in this handbook is to protect and restore the rates and patterns of the processes and elements of the ecosystems that salmon and other native fishes require for survival. This handbook highlights salmon and other native fishes in the ecosystem, as indicators of the condition of ecosystem processes and elements.

The objective of protection and restoration is to maintain (where they exist) or return to (where they have been perturbed by human impacts) conditions characterized by rates and patterns of ecosystem processes and elements that sustain native fishes. Recovery is the achievement of such conditions. The levels at which native fishes are sustained must be established through social, political or legal processes, and may range from minimal levels to levels sufficient to support historic uses. Although pre-European settlement conditions likely will never be restored on broad or regional scales, the intent is to move toward rates and patterns of ecological processes and elements essential to native fishes and the maintenance and creation of their habitats, such that the future productive capacity of broad geographic regions for those fishes is increased.

An ecosystem approach is concerned with not only the rates and patterns of the processes and elements of the ecosystems that salmon and other native fishes require for survival, but with the range of variation in these rates and patterns across the landscape, which is key to the diversity and evolutionary potential of native fish species. Therefore, this handbook also emphasizes protecting and restoring a range of ecosystem types across the landscape.

To implement the ecosystem approach described above, the cornerstone of this handbook is protection and restoration of watersheds that support a diversity and abundance of native fishes and represent a diversity of ecosystem types. Such areas include the critical areas identified by the Oregon Chapter of the American Fisheries Society (defined as the best remaining examples of ecosystem types or at-risk aquatic species) (Oregon AFS 1993), key watersheds identified in the President’s Forest Plan (defined as relatively intact areas containing at-risk salmon populations) (FEMAT 1993), and source watersheds for salmon identified by Oregon Department of Fish and Wildlife (defined as the watersheds having better than average salmon populations in a river basin) (Oregon Department of Fish and Wildlife unpublished data).

Protection of high priority, relatively healthy areas (i.e., areas whose rates and patterns of ecosystem processes and elements sustain a diversity and abundance of native fishes) is the most important first step in an ecosystem-based protection and restoration strategy. This is because protecting relatively healthy ecosystems is much more certain and less expensive than restoring degraded ecosystems, and the relatively healthy areas provide the source populations for recovery of native fish populations.

Restoration, to be most effective, should build on protection efforts. Protection alone normally should be applied to relatively healthy ecosystems, while both protection and restoration often need to be applied to relatively degraded ecosystems. ‘Protection can be effective in the absence of restoration, but restoration cannot be effective without protection. Moreover, for restoration to be effective, protection is needed throughout the watershed. Restoration should occur within a landscape context of protection from future degradation. For these reasons, and because of the naturally healthier assemblages often occurring in minimally disturbed areas, protection is considered to be a higher priority than restoration.

Protection includes enforcement of laws requiring, for example, minimum streamflows, irrigation diversion screens, pollution control, water quality, and protection of fish from overfishing or poaching. It includes implementing definitive land and water management strategies, providing incentives for good land and water management, and purchasing land. Protection also may include active measures to reduce the risk of future perturbation, such as road-related treatments, cattle fencing, and riparian set asides. Protection and restoration may take place at any scale, but the intended scale should be clear. For example, if a watershed is considered to be very degraded, then restoration is the most appropriate response, but relatively healthy areas within the watershed should still be protected. By the same token, a relatively healthy watershed may have degraded sites within it that require restoration.

The areas that are relatively healthy today, and that represent the best remaining examples of ecosystem types, are not necessarily the most potentially productive areas for salmon. The relatively healthy areas tend to be at higher elevations, while the historically most productive areas tend to be the more degraded low elevation habitats. As a result, protecting relatively healthy areas will not provide immediate benefits for salmon, although it is the most important starting point. A long term strategy to recover salmon also requires restoring lower-elevation freshwater and estuarine habitats.

Protection and Restoration Within Watersheds

Planning protection and restoration activities that allow a return to conditions characterized by rates and patterns of ecosystem processes and elements that sustain native fishes requires some type of watershed analysis. Watershed analysis is structured around a series of questions whose answers ‘provide a model of ecosystem processes and elements, disturbance history, and current and potential future conditions (Montgomery et al. 1995). The checklist in Section III of this handbook steps through the key elements of watershed analysis for any lands, regardless of ownership. Other watershed analysis procedures also are available. FEMAT (1993) calls for restoration on federal lands to be based on watershed analysis, and protocols have been developed (Anonymous 1994, Regional Ecosystem Office 1995). A draft strategy for river basin assessment has been developed by the Oregon Watershed Health Program (Bach 1994). EPA (1995) reviews other approaches that are available.

Watershed analysis should characterize the conditions in a watershed that are, and are not, conducive to native fishes, such as inputs of sediments and large woody debris, flow regimes, and temperature loadings. It should identify the natural and human-caused factors that create those conditions, which should lead to protection and restoration strategies that will foster watershed recovery.

Watershed analysis should identify reference conditions or reference sites, which provide a target for achieving recovery. This target should represent conditions that sustain native fishes at desired levels, which are likely to be similar to (or represent movement toward) those conditions in which the landscape developed and its component parts (plants, salmon and other organisms) evolved. Because human-caused factors, such as the introduction of exotic species, losses in soil productivity through erosion, species extirpations, pollution, and permanent cultural features on the landscape (roads, cities, farms etc.) may preclude a complete return to pre-European settlement conditions, the reference sites likely will not represent pre-European settlement conditions, but should embody a movement toward such conditions. In other words, it is possible to use pre-European settlement conditions as benchmarks or reference conditions, and then set some amount of variance from these as attainable goals; the reference condition need not be attainable to be useful (Hughes 1995).

Where human activities create conditions that are detrimental to native fishes (i.e. by negatively influencing the rates and patterns of the ecosystem processes and elements that are important for fish), the first step in a restoration program is to stop such activities or modify them such that damage to fish populations is eliminated or reduced. Stopping human-caused activities that cause degradation or impede recovery often results in dramatic improvements in Salmonid habitats, and is often the least expensive and only activity necessary to restore Salmonid habitat (Kauffman et al. 1992). If the watershed cannot recover naturally once human-caused perturbations have been stopped, or cannot recover quickly enough (for example, before imperiled native fish populations become extinct), restoration measures may be required. However, it is extremely important that restoration not be implemented until removal of human-caused perturbations has proven inadequate for recovery (Kauffman et al. 1992). In some cases (such as livestock grazing or dams) the human-caused perturbations are in or near the stream channel; in other cases (such as improperly maintained roads) the perturbations are upslope of the channel; for this reason the entire watershed must be considered. Some of the most immediate forms of protection include cessation of stocking and harvesting.

If conducting a watershed analysis is not feasible, a conservative approach to restoration should be taken. In this situation, restoration projects should focus on treating and reducing upslope hazards and allowing riparian ecosystems to recover, because these activities will help a watershed recover, and entail minimal risk. In the face of limited information, redoubling protection efforts may make more sense than pursuing restoration. At the same time, efforts should be made to gain an understanding of the key ecosystem processes and elements affecting the watershed and its native fishes.

Treating and reducing upslope hazards is important because events such as fire, landslides and debris flows are natural features of the Pacific Northwest landscape; yet their frequency, magnitude, spatial pattern, and composition have been greatly altered by human land use activities, primarily fire control and road construction. As a result, their ecological impact is severely magnified. Treatment of road stability, road drainage, channel crossings, and road location problems is the most urgent need for forested watersheds (Frissell 1993).

Well-vegetated riparian ecosystems that are connected to and interact with the stream channel are less likely to be irretrievably damaged by disturbance events than degraded riparian ecosystems. Unless the dynamic and interactive processes between the riparian floodplain and the stream channel are allowed to function, the potential for salmonid habitat recovery is limited (Kauffman et al. 1992). Restoration of riparian vegetation is fundamental for the successful restoration and perpetuation of salmonid populations. In addition, removal or treatment of valley bottom roads is key to restoring riparian ecosystems and the connectivity between floodplains and stream channels.

Other Considerations

This handbook emphasizes biological considerations for prioritizing geographic areas, river basins, watersheds, and activities within watersheds. The first priority should be widespread distribution of major protection efforts statewide, according to the considerations in this handbook. However, where biological priorities within an ecoregion or basin are otherwise equal, policy makers may need to choose among high-priority areas for allocating limited resources. The developers of this handbook offer the following likelihood of success and operational considerations.

The likelihood of success will be greater if there is an understanding of the landscape character of a watershed and the factors that place its ecological resources at risk; and there are attainable restoration goals that have been developed in light of present conditions and projected future conditions. It is important that success be measured in a context of agreed-upon goals and objectives. Implicit in gauging success is a comprehensive set of goals and objectives defining desired conditions (elements and processes), and the establishment of explicit reference conditions, against which results are compared; both are the product of a comprehensive assessment. Success (or the lack of it) should be quantitatively monitored through use of an appropriate survey design and indicators.

Higher priority should be given where there is a context of protection that would help prevent future degradation or complement new protection or restoration measures, or where a comprehensive scientifically-based protection and restoration strategy exists. The ability to implement an effective monitoring program and the availability of considerable high-quality baseline data also should confer higher priority, all else being equal.

Major operational considerations relate to land ownership, such as whether the land ownership pattern provides opportunities for protection and restoration, whether there is the opportunity for cooperative public and private funding, and whether the proposed area is in a treaty drainage. The existence of ongoing cooperative management and restoration efforts or active collaboration of interest groups, and consistency with state, tribal or federal restoration policies also should confer high priority. Finally, high priority should be given where a high cost effectiveness of restoration investments can be expected, and where there are skills and operational experience in planning, implementing and monitoring large scale, multi-year restoration efforts. (Note, however, that existing restoration projects, data bases, and experience may be located in areas where benefits to native fishes may be relatively low. Future protection or restoration projects should not be located solely to build on existing activities or data bases.)

In conclusion, this handbook presents a step-by-step ecosystem-based approach for planning protection and restoration at multiple spatial scales. It places protection and restoration in the context of the ecosystem and the landscape. It is intended to provide guidance for taking action in the near future, based on available information, to make freshwater ecosystems more conducive to the survival and recovery of salmon and other native fishes.

References

Anonymous. 1994. A federal agency guide for pilot watershed analysis. Version **1.2.**

Bach, L. 1994. Draft strategy for comprehensive river basin assessment. Oregon Watershed Health Program, June 7, 1994.

Doppelt, B., M.C. Scurlock, C.A. Frissell, and J.R. Karr. 1993. Entering the Watershed: a new approach to save America's river ecosystems. Island Press.

Environmental Protection Agency (EPA). 1995. A watershed assessment primer. EPA report 9 10/B-94-005, Region 10, Seattle, WA.

Forest Ecosystem Management Assessment Team (FEMAT). 1993. Forest ecosystem management: An ecological, economic, and social assessment. US Forest Service, National Marine Fisheries Service, Bureau of Land Management, Fish and Wildlife Service, National Park Service, and Environmental Protection Agency, Portland and Washington, DC.

Frissell, C.A. 1993. A new strategy for watershed restoration and recovery of Pacific salmon in the Pacific Northwest. Report prepared for the Pacific Rivers Council, Eugene, Oregon.

Henjum, M.G., J.R. Karr, D.L. Bottom, D.A. Perry, J.C. Bednarz, S.G. Wright, S.A. Beckwitt, and E. Beckwitt. 1994. Interim Protection for late-successional forests, fisheries, and watersheds: National forests east of the Cascade crest, Oregon and Washington. The Wildlife Society, Bethesda, MD.

Hughes, R.M. 1995. Defining Acceptable Biological Status by Comparing with Reference Conditions. In W.S. Davis and T.P. Simon (eds.) Biological Assessment and Criteria: Tools for Water-Resource Planning and Decision Making. Lewis Publishers, 1995.

Kauffman, J.B., R.L. Beschta, and W.S. Platts. 1992. Fish habitat improvement projects in the Fifteen mile Creek and Trout Creek Basins of Central Oregon: Field review and management recommendations. Bonneville Power Administration, December 1992.

Montgomery, D.R., G.E. Grant, and K. Sullivan. 1995. Watershed analysis as a framework for implementing ecosystem management. Water Resources Bulletin (in press).

Noss, R.F. and A.Y. Cooperrider. 1994. Saving Nature's Legacy: Protecting and Restoring Biodiversity. Island Press, Washington, D.C.

Oregon Chapter of the American Fisheries Society (Oregon AFS). 1993. Oregon critical watersheds database. Oregon Department of Fish and Wildlife. Corvallis, Oregon.

Regional Ecosystem Office. 1995. Ecosystem analysis at a watershed scale. Version 2.1. Regional Ecosystem Office, Portland, Oregon.

Thiele, S.A., C.W. Külsgaard, and J.M. Omernik. Draft. The subdivision of the coast range ecoregion of Oregon and Washington. U. S. Environmental Protection Agency. Corvallis, Oregon.

PART 3.
DEFINITIONS

anadromous salmonids -- Members of the Salmonidae (genus Oncorhynchus) that return to fresh water to spawn. Includes salmon, steelhead, and sea-run cutthroat trout.

biodiversity (biological diversity) -- The variety of life forms and processes, considered at the gene, species, and ecosystem levels.

ecoregion -- An area of similar climate, geology, soil, potential natural vegetation, and general land use. Watersheds or reaches in the same. ecoregion, but different basins, typically support similar assemblages and process rates. Reaches in the same drainage but different ecoregions tend to support different assemblages.

ecosystem -- A unit comprising interacting organisms considered together with their environment (e.g., marsh, watershed, and lake ecosystems).

ecosystem function -- The normal or characteristic role of an ecosystem or ecosystem component. Functions characterize what it is that ecosystems or ecosystem components do. For riparian ecosystems, this might include detention of surface water, storage of subsurface water, carbon and nutrient cycling, retention of particulates, maintenance of plant communities and detrital biomass, maintenance of habitat structure, diversity and connectivity, and others.

elements -- Material things with observable structure and composition (patterns). Ecosystem elements include biological elements such as genes, species, assemblages, and communities. Other ecosystem elements include chemical concentrations, hydrological characteristics, substrate, channel and bank condition, and riparian land cover.

FEMAT -- Forest Ecosystem Management Assessment Team. Commonly referred to as the "Option 9 Plan" or the "President's Forest Plan."

processes -- In an ecosystem, the activities that generate and maintain ecosystem elements; they are typically measured as rates. Ecosystem processes include biological processes such as genetic recombination, species migration and evolution, and nutrient cycling and energy flow through communities. Other critical processes for stream/riparian ecosystems include substrate and water delivery.

protection -- The prevention of activities that would degrade, or slow the recovery of, watersheds or components of watersheds. * Protection may include modification of planned human activities that would cause degradation, or the removal of existing impediments to recovery.

recovery -- The re-establishment of conditions in watersheds or components of watersheds characterized by rates and patterns of ecosystem processes and elements that sustain native fishes at socially, politically or legally established levels. Such levels could range from abundance adequate to preclude listing under the Endangered Species Act, to abundance sufficient to support historic commercial, recreational, cultural and aesthetic uses.

reference condition — A target for achieving recovery of watersheds or components of watersheds. The reference condition may be characterized through a historical analysis (including written and oral history, old photographs, comparison with similar ecosystems, and educated inference). It may be represented by a set of reference sites (see below).

reference sites – Watersheds, streams, or sites chosen to represent a reference condition.

restoration -- The process by which watersheds or components of watersheds recover (see **recovery).** Restoration should allow or promote the achievement of a condition similar to that of the reference condition; monitoring should measure the extent to which this is occurring.

river basin -- Drainage area of a large river system that includes several watersheds, typically larger than 200 square miles.

salmonids -- Members of the Salmonidae. Includes anadromous forms (salmon, steelhead, and sea-run cutthroat trout) and resident forms (such as bull trout, other resident trouts, and mountain whitefish).

watershed -- A catchment or drainage basin of approximately 20 to 200 square miles.

> **aquatic diversity areas** -- Defined by the Oregon Chapter American Fisheries Society as areas that **1)** contain native fauna at immediate risk or likely to be vulnerable to future disturbance; 2) whole watersheds that represent the best remaining examples of native aquatic ecosystems in a relatively unaltered state; 3) areas of high biological diversity; or 4) connecting corridors that provide essential links between habitats in **l),** 2) and 3).
>
> **key watersheds -- As** defined by FEMAT, watersheds containing 1) habitat for potentially threatened species or stocks of anadromous salmonids or other potentially threatened fish, or 2) greater than 6 square miles of high-quality water supply and fish habitat.
>
> **recovery watersheds** -- Watersheds that are either adjacent to source watersheds, or disjunct reaches of critical habitat that potentially limit populations originating from source watersheds.
>
> **source watersheds** -- Watersheds that contain streams where native wild salmonids are relatively more abundant than in other streams of the river basin. This is usually because the condition of the habitat is better than average, but in some cases habitat may be quite degraded.

*"watersheds or components of watersheds" implies several spatial scales: geographic areas, river basins, watersheds or components of watersheds (such as stream reaches or fish assemblages).

PART 4.
GETTING STARTED

First, consider whether the goals of this handbook are compatible with your objectives. The handbook will be useful to those whose focus is restoration of salmon and aquatic biodiversity within a watershed context. It will not help address conditions that affect particular salmon populations outside of a watershed context, such as mainstem passage and harvest; however, once high-priority watersheds are identified through this process, policy makers should place high priority on addressing all of the conditions that affect the native salmon populations. This handbook also does not address terrestrial biodiversity.

Second, consider how the handbook will be used. This handbook offers a science-based foundation for protection and restoration. It provides a basis to improve the biological benefits resulting from restoration investments. It is intended to be flexible. It may be used at a variety of scales or for a range of program or project considerations, such as to: 1) generate projects for which funds will be sought; 2) develop comprehensive watershed restoration plans; 3) assist funding entities in developing guidance for applicants; and 4) provide a basis for reviewing and evaluating proposals. It is important to consider when scientifically-based criteria should be used. For example, some may wish to apply scientific criteria at the very beginning of the process, as the basis for determining where in the region, state or basin funds will be spent. In other cases, users may desire to use other criteria (such as economic need or likelihood of success) to identify geographic locations where funds are to be spent, and may wish to use this handbook only to screen projects identified within designated watersheds.

Although it is not possible to review all of the possible applications here, potential users should first consider how this handbook can best be used to fit their needs--where in the proposal solicitation and review process, and at which geographic scales. To prevent confusion and inaction, such decisions should be made very early in the process.

Third, specify the geographic scales and units that will be addressed. Users who plan to work at regional, state, geographic area, or river basin scales should use Section II, and will need to identity a regional team to conduct the prioritization. Those who plan to identify priority activities within selected watersheds should use Section III, and will need to identify a watershed team to conduct that prioritization.

Finally, strategies for public involvement and scientific peer review should be identified before prioritization begins.

SECTION II.
PRIORITIZING GEOGRAPHIC AREAS, RIVER BASINS AND WATERSHEDS FOR PROTECTION AND RESTORATION

PART 1.

PROCEDURE FOR PRIORITIZING GEOGRAPHIC AREAS, RIVER BASINS AND WATERSHEDS FOR PROTECTION AND RESTORATION

Geographic areas, river basins and watersheds should be prioritized by a multi-disciplinary team of experts (including hydrologists, ecologists, and fisheries scientists). This regional team should be familiar with data at the appropriate scales--region, state, or river basin. The prioritization process is not intended to be used as a cookbook, but rather to establish the basis for logical step-by-step reasoning.

units but with some differences based on how salmon are managed and distributed (Section II., Part 2). After priority river basins are identified through another iteration of Step 2, identity watersheds within these priority river basins. Watershed designations are available from state and federal forest and water managers. Then proceed with Step 3 to identify priority watersheds.

STEP 2. IDENTIFY PRIORITY GEOGRAPHIC AREAS OR RIVER BASINS

Use the following considerations (not in order of importance) to prioritize geographic areas or river basins. An explanation of the considerations and a rating form are included. Total the ranks to obtain preliminary priorities (higher scores indicate higher priority) for current biological and ecological resources (A), integrity and risk (B), and optimism and potential (C). Current biological and ecological resources (A) are the primary indicator of priority; the other two indicators should be used as modifiers for areas that have rank similarly for current biological and ecological resources. The analysis team(s) then should confirm the preliminary priorities to make certain that they are consistent with the objectives of the process. In its deliberations, the team should consider the quantity and quality of data that underlie the rankings.

Section II., Part 2 contains an example of how the considerations were used to prioritize river basins in western Oregon.

A. Current biological and ecological resources for geographic areas and river basins.

1. Number of native anadromous salmonid species/races: Fill in the number of native anadromous salmonid species/races [pink, chum, sockeye, coho; spring, summer, fall, winter chinook; winter, summer steelhead; coastal cutthroat trout] present within the geographic area or river basin. To be considered "present", the species/race must spawn or rear in the area, not just migrate through it. Rank the numbers of species/races, divide the ranks into thirds, and score the relative ranks as follows: 1 = lowest third, 2 = middle third, 3 = highest third.

   The number of native (indigenous, naturally-spawning anadromous species or races is a measure of the diversity of anadromous salmonid fishes. Protection and restoration of areas having larger numbers of native anadromous salmonid species and races will yield greater benefits to anadromous salmonid diversity than protection and restoration of areas having smaller numbers of native anadromous salmonid species and races.

2. Relative abundance: Fill in the abundance of native anadromous salmonids relative to other geographic areas being considered, or other river basins within the geographic area. Use indicators 1 = low (i.e. low abundance relative to other geographic areas or river basins being considered), 2 = medium, 3 = high.

   *Native anadromous Salmonid abundance is an indication of the productivity of the geographic area, river basin or watershed; its ability to "seed" the recovery of other areas; and its ability to support a sustainable **fishery.***

3. Native aquatic assemblage diversitv: Fill in the level of native aquatic assemblage diversity relative to other geographic areas being considered, or other river basins within the geographic area. Use indicators **1** = low, 2 = medium, 3 = high. In addition, a plus "+" may be given to signify the presence of unique genetic or life history characteristics; plusses may be used for tie-breakers in the final scoring.

High native aquatic assemblage (all native fishes and other aquatic species) diversity is indicated by the presence of ***high fish*** *species richness, uncommon life histories, uncommon geographic locations, unique local adaptations or rare alleles, and many life history traits. A high degree of genetic, assemblage or community diversity also indicates high aquatic assem blage diversity.*

4. Number of key watersheds. source areas or aquatic diversity areas: Fill in the number of source or key watersheds or aquatic diversity areas for geographic areas or river basins. Rank the numbers, divide the ranks into thirds, and score the relative ranks as follows: 1 = lowest third, 2 = middle third, 3 = highest third.

Key, source and recovery watersheds and aquatic diversity areas generally represent the best remaining examp Ies of aquatic biodiversity.

5. Ecoregions represented: Fill in the number of ecoregions represented by the geographic area or river basin being considered. Rank the numbers, divide the ranks into thirds, and score the relative ranks as follows: **1** = lowest third, 2 = middle third, 3 = highest third.

A diversity of ecoregions should be represented, to help make certain that key elements of biodiversity are represented

6. Other ecological benefits: Fill in the relative extent to which the river basin being considered fills a critical role within the larger area. Use indicators 1 = low, 2 = medium, 3 = high.

This consideration does not apply for geographic areas or for self-contained river basins. However, it does apply for river basins that are part of larger systems (e.g. Umpqua, Rogue, Columbia, etc.) A strategic selection of basins could result in broader benefits to the larger area. For example, basins where connectivity among habitats can be provided, human-caused passage obstructions can be removed, benefits to critical life history stages can be provided, or downstream impacts can be remedied, would be ranked high. In addition, aquatic restoration activities conducted in the basin that will likely produce ancillary benefits to terrestrial ecological resources would be ranked high.

The following considerations apply to geographic areas and river basins (Step 2), and also will be applied to watersheds (Step 3).

B. **Integrity of and risks to these resources.**

1. Relative integrity: Fill in the relative integrity (lack of human-caused disturbance) of geographic areas, river basins or watersheds using indicators 1 = low, 2 = medium, 3 = high.

Ecological integrity can be compromised because of the proximity, duration and intensity of human-caused disturbance affecting the environmental resources within an area. For example, low integrity is often reflected by high soil erosion and water pollution, high human population density and population growth rates, intensive land use, management for purposes other than protection of biodiversity, mine sites and mining claims, toxic waste sites, and high road density.

2. Relative risk: Fill in the relative risk to current biological and ecological resources related to natural features using indicators **1 =** low, **2 =** medium, 3 = high.

Natural features to be considered include steepness, soil types,

____

____

____

STEP 3. IDENTIFY PRIORITY WATERSHEDS

For priority river basins, identify priority watersheds according to the following considerations. Section II., Part 2 includes an example of prioritizing watersheds.

First Prioritv

Watersheds that comprise aquatic diversity areas, key watersheds and salmon source areas are first priority.

Second Priority

Watersheds that comprise aquatic diversity areas and salmon source areas, or key watersheds and salmon source areas, are second priority.

Third Prioritv

Those source areas not identified as aquatic diversity areas or key watersheds, and other areas that provide other ecological benefits. Such benefits include the presence of historically productive low-elevation areas that provide habitat connectivity in conjunction with the first and second priorities; and providing sources of cool water (springs, seeps etc.).

Where further refinements of these priorities are needed (i.e. if many watersheds qualify under a particular priority level), the following considerations may be used:

1. Number of species of native anadromous salmonids present in the watershed.

2. Aquatic assemblage diversity, or uniqueness of the watershed.

3. The spatial arrangement of watersheds--whether a given watershed contributes to spatial separation of watersheds chosen (diversity), or contributes to clustering in a contiguous group (redundancy).

4. Number of ecoregions within the watershed.

A. DIVERSITY, ABUNDANCE, AND CONNECTIVITY

GEOGRAPHIC AREA, BASIN, OR WATERSHED	1			2	3			4			5			6	TOTAL
	NO.	RANK	THIRD		NO.	RANK	THIRD	NO.	RANK	THIRD	NO.	RANK	THIRD		
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															
16															
17															
18															
19															
20															
21															
22															
23															
24															
25															
26															
27															
28															
29															
30															

Where applicable, "NO." refers to the number asked for in the specific question.
RANK refers to the rank of that number relative to the other areas being considered.
THIRD refers to whether the rank falls into the lowest third (1), middle third (2) or highest third (3)

GEOGRAPHIC AREA BASIN, OR WATERSHED	B. IMPACT/RISK 1	2	3	C. OPTIMISM/ POTENTIAL 1	2		TOTAL	NOTES
1								
2								
3								
4								
5								
6								
7								
8								
9								
IO								
11								
12								
13								
14								
15 .								
16								
17		-						
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								

PART 2.

EXAMPLE OF PRIORITIZING RIVER BASINS AND WATERSHEDS IN WESTERN OREGON

To aid in using the considerations for prioritizing geographic areas, river basins and watersheds, the following example is offered. The group that developed the prioritization framework used the process outlined in Section II, Part **1** to prioritize river basins in three geographic areas of western Oregon.

First, Oregon was divided into five geographic areas that represent large-scale ecological diversity in the state (Figure 2). Four of these geographic areas (all except the Southeastern area) are within the current range of anadromous salmonids. The group focused its test prioritization on the three geographic areas in western Oregon (North Coast, South Coast, and Willamette River Basin) because of greater availability of data. Although geographic areas could be prioritized according to the process outlined in Section II, Part 1, the group believed that ecological diversity should be addressed across the landscape, and each geographic area should be represented in protection and restoration programs. Therefore, the group did not prioritize the geographic areas, but began its prioritization at the river basin level.

The three geographic areas in western Oregon were divided into river basins (Table 1) and watersheds (Table 2).

Prioritizing River Basins

River basins were rated according to the considerations in Section II, Part 1; results for the North Coast are shown in Table 3. The responses for an example river basin, the Nehalem, are explained below:

<u>Nehalem River</u>

A. Diversity, Abundance and Connectivity

1. Number of native anadromous salmonid species/races present within the river basin: 6 **(coho, fall chinook, chum, steelhead, sea-run cutthroat trout, spring chinook). Scores for North Coast basins for this question ranged from 3 (Coastal Lakes) to 7 (Siletz). The score for the Nehalem fell into the highest third of responses. Final score for highest third = 3.**

2. Abundance of native anadromous salmonids relative to other river basins: **High, score = 3.**

3. Aquatic assemblage diversity relative to other river basins: According to Oregon State University's fish data base, which includes all fishes but not amphibians or invertebrates, 5 nonsalmonid fish species are present in the Nehalem basin. (We caution that these data are limited by access, sampling gear, and the presence of museum specimens, and therefore underestimate such species. In addition, other components of aquatic

assemblage diversity ideally should be included. However, this source was used for illustration because of its availability.) In addition, a plus "+" is given because of the presence of Ceratomyxa Shasta-resistant chinook (plusses may be used for tie-breakers in the final rating). **Score =** 5+. **The scores for this question ranged from 1 (Salmon R) to 13+ (Lower Columbia); Nehalem fell into the second third of responses. Final**

included. According to Nehlsen et al. (1991), the Nehalem River has one at-risk salmon species. Tillamook and Nestucca each have two, and Alsea has three.

C. Optimism and Potential

1. Degree of optimism that freshwater or estuarine ecosystems can be protected or restored. **The ratings of Nicholas (1993) were used for this consideration. He assigned high, medium and low values to each salmon species/race on the Oregon coast. For the Nehalem, degree of optimism for coho was rated high, for fall chinook was rated medium, for spring chinook was rated low, for winter steelhead was rated medium, and for chum was rated low. If simple point assignments are made (e.g. low = 1, medium = 2, high = 3), an average rating can be obtained for all species. For the Nehalem this average was 1.8 (low to medium); ratings for the other three high priority basins were similar.**

2. Potential scope of increase of anadromous salmonid populations if protection and restoration are effective. **The ratings of Nicholas (1993) were also used for this consideration. He assigned high, medium and low values to each salmon species/race on the Oregon coast. For the Nehalem, potential scope of increase was rated high for coho, medium for fall chinook, medium for spring chinook, high for winter steelhead, and low for chum. The average rating according to the point assignments defined in the previous consideration was 2.2 (medium to high), which is higher than the other three high priority basins.**

Conclusions from parts B. and C.

Based on the results of these considerations, the Nehalem appears to be a good river basin to begin protection and restoration efforts. The Alsea would be a good second choice, because of its high level of impact and the number of at-risk salmon species. In addition, if the Nehalem, Tillamook or Nestucca basins were chosen for the first efforts, the Alsea would be a good second

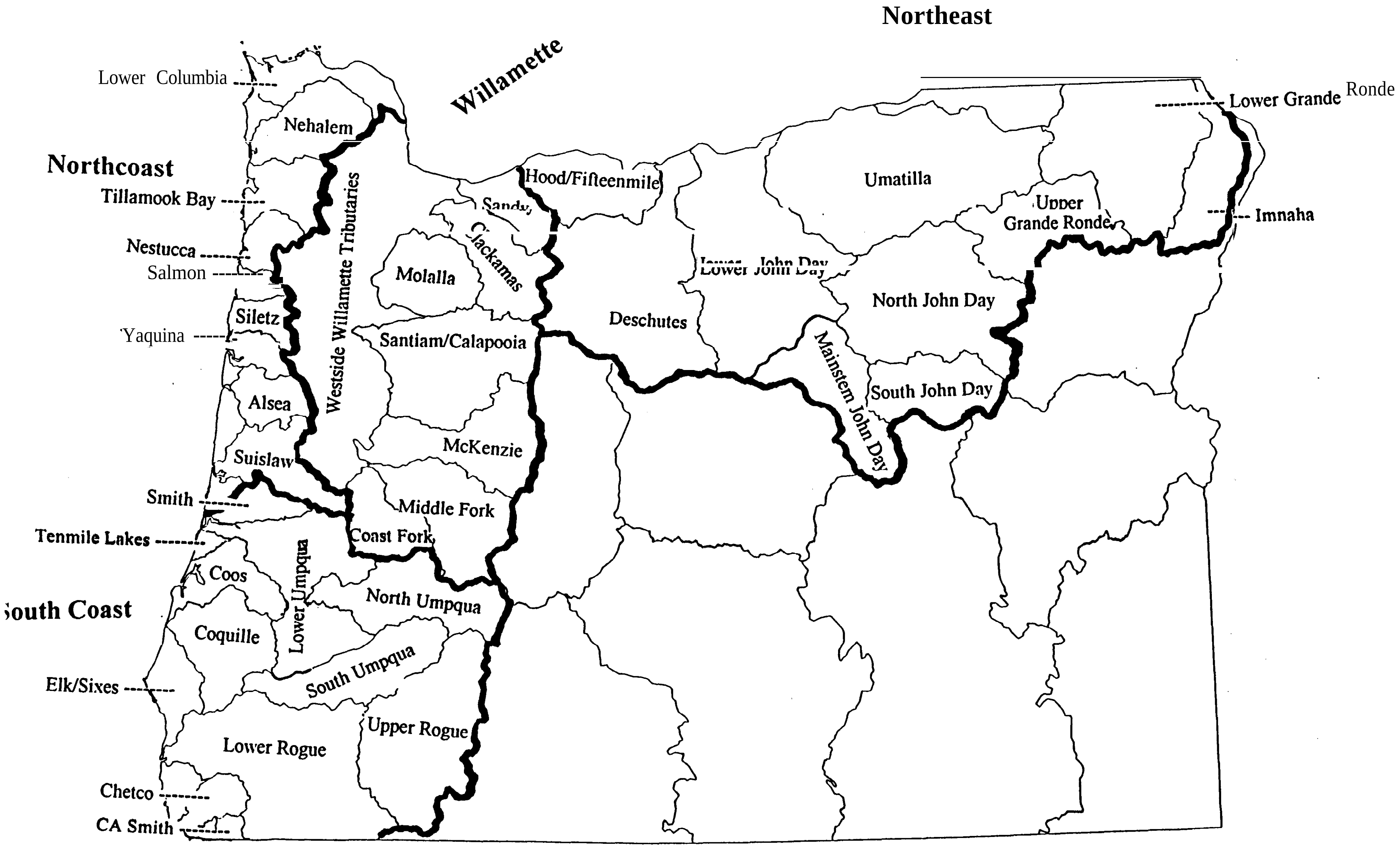

Figure 2. Oregon geographic areas arid river basins in the range of salmo'n.

TABLE 1. OREGON RIVER BASINS IN THE RANGE OF SALMON BY GEOGRAPHIC AREA

GEOGRAPHIC AREA	BASIN
North Coast	Lower Columbia
North Coast	Nehalem
North Coast	Tillamook Bay
North Coast	Nestucca
North Coast	North Coast Small Ocean Tributaries
North Coast	Salmon
North Coast	Siletz
North Coast	Yaquina
North Coast	Alsea
North Coast	Suislaw
North Coast	Coastal Lakes
South Coast	Smith
South Coast	Lower Umpqua (downstream of confluence of South Umpqua and Cow Creek)
South Coast	North Umpqua
South Coast	South Umpqua
South Coast	Tenmile Lakes
South Coast	coos
South Coast	Coquille
South Coast	Elk/Sixes
South Coast	Lower Rogue (below Gold Ray Dam)
South Coast	Upper Rogue (above Gold Ray Dam)
South Coast	South Coast Small Ocean Tributaries
South Coast	Chetco
South Coast	CA Smith
Willamette	Clackamas
Willamette	Molalla
Willamette	Santiam/Calapooia
Willamette	Westside Willamette Tributaries
Willamette	McKenzie
Willamette	Middle Fork Willamette
Willamette	Coast Fork Willamette
Willamette	Sandy
Northeast	Hood/Fifteenmile
Northeast	Deschutes
Northeast	Lower John Day
Northeast	Mainstem John Day
Northeast	North John Day
Northeast	South John Day
Northeast	Umatilla
Northeast	Walla Walla
Northeast	Lower Grande Ronde (downstream of RM 100)
Northeast	Upper Grande Ronde (upstream of RM 100)
Northeast	Imnaha

TABLE 2.

AQUATIC DIVERSITY AREAS, KEY WATERSHEDS, AND SOURCE AREAS FOR ANADROMOUS SALMONIDS IN OREGON

							SOURCE SPECIES							
BASIN	STREAM	KY TI	KY T2	AFS ADA	AFS CR	SRCE	CO	CHF	CHS	CHM	STW	STS	CTS	COMMENTS
LOWER COLUMBIA	CULLABY LK. COMPLEX			1										
LOWER COLUMBIA	CARCUS CR.			1										
LOWER COLUMBIA	LEWIS & CLARK R.			1		1	1							
LOWER COLUMBIA	FOX CR.			1										
N COAST SM OCEAN TRIBS	ECOLA CR.			1		1	1				1			SOURCE AREAS ARE BOTH FORKS ABOVE CONFLUENCE.
N COAST SM OCEAN TRIBS	N. FK. NECANICUM R.					1	1							
N COAST SM OCEAN TRIBS	STANLEY LK. & TRIBS. (NECANICUM)					1	1							
N COAST SM OCEAN TRIBS	NECANICUM R.					1	1			1	1			STEELHEAD RM 8 TO RM 20; COHO ABOVE RM 18; CHUM RM 5 TO RM 13
N COAST SM OCEAN TRIBS	MAIL CR. (NECANICUM)					1	1							
N COAST SM OCEAN TRIBS	BEERMAN CR. (NECANICUM)					1	1							
N COAST SM OCEAN TRIBS	ARCH CAPE CR.					1	1				1			
N COAST SM OCEAN TRIBS	WHISKEY CR. (NETARTS BAY)					1				1				
N COAST SM OCEAN TRIBS	JEWELL CR. (SAND LAKE)					1				1				
N COAST SM OCEAN TRIBS	NESKOWIN CR. UPPER MAINSTEM					1	1				1			ABOVE LEWIS CR.
N COAST SM OCEAN TRIBS	BUTTE CR. (NESKOWIN CR.)					1	1							
N COAST SM OCEAN TRIBS	NESKOWIN CR. LOWER MAINSTEM					1				1				BELOW FALL CR.
N COAST SM OCEAN TRIBS	N FK BEAVER CR.	1		1		1	1				1		1	ABOVE LEWIS CR.
N COAST SM OCEAN TRIBS	YACHATS R.	1			1									
N COAST SM OCEAN TRIBS	SCHOOL FORK	1		1										
N COAST SM OCEAN TRIBS	S. FK. YACHATS R.	1				1					1			
N COAST SM OCEAN TRIBS	CUMMINS CR.	1		1										
N COAST SM OCEAN TRIBS	BOB CR.	1		1										
N COAST SM OCEAN TRIBS	TENMILE CR.	1		1										
N COAST SM OCEAN TRIBS	ROCK CR.	1		1										
N COAST SM OCEAN TRIBS	BIG CR.	1		1										
N COAST SM OCEAN TRIBS	CAPE CR.			1										
NEHALEM	N. FK. NEHALEM R. MAINSTEM					1		1						RM 14 TO RM 17
NEHALEM	GODS VALLEY CR. (N. FK. NEHALEM)					1		1						
NEHALEM	L. N. FK. NEHALEM R.					1	1				1			
NEHALEM	SWEET HOME CR. (N. FK. NEHALEM)													
NEHALEM	COAL CR. (N. FK. NEHALEM)					1				1				
NEHALEM	BOBS CR. (N. FK. NEHALEM)													
NEHALEM	BIG RACKHEAP CR. (N. FK. NEHALEM)			1										
NEHALEM	NEHALEM R. ESTUARY				1									
NEHALEM	SOAPSTONE CR. (N. FK. NEHALEM)					1		1						
NEHALEM	ANDERSON CR. (N. FK. NEHALEM)													
NEHALEM	NEHALEM R.				1	1			1					THE LOOP NORTH OF U.S. RTE 26. (APPROX. RM 36-l 16); CHS RM 35-90
NEHALEM	CRONIN CR.					1		1						
NEHALEM	COOK CR.					1		1			1			
NEHALEM	SALMONBERRY R.			1				1			1			
NEHALEM	FOLEY CR.			1										
NEHALEM	LOST CR.					1		1			1			
NEHALEM	ROCK CR. LOWER			1		1			1					CHS BELOW RM 10; COHO RM 15-22; STLHD RM 20-22.
NEHALEM	DEER CR.			1										
NEHALEM	WALKER CR.			1										
NEHALEM	HAMILTON CR. (FISHHAWK CR. #1)			1										
NEHALEM	NORTHRUP CR.			1										
NEHALEM	BENEKE CR. (WALKER CR.)			1										
NEHALEM	FISHHAWK CR. #1			1										
NEHALEM	HUMBUG CR.			1		1		1						STLHD IN W. FK.; COHO IN FORKS & MCCLURE CR.
NEHALEM	N. FK. ROCK CR.			1		1					1			
NEHALEM	LOUISIGNANT CR. #1			1										
NEHALEM	BUSTER CR			1										
NEHALEM	CROOKED CR.			1										
NEHALEM	MESSING CR.			1										
NEHALEM	PEBBLE CR.			1										

NEHALEM	CLEAR CR.			1		1	1							
NEHALEM	S. FK. ROCK CR			1		1	1				1			
TILLAMOOK BAY	MIAMI R. UPPER MAINSTEM			1		1		1			1			ABOVE PROUTY CR.
TILLAMOOK BAY	ELKHORN CR.	1				1	1							
TILLAMOOK BAY	MIAMI R. LOWER MAINSTEM			1		1				1				SOURCE FOR CHUM BELOW MIMICK CR.
TILLAMOOK BAY	N. FK. TRASK R.				1	1			1		1			
TILLAMOOK BAY	N. FK. OF N. FK. TRASK R.			1		1					1			

AQUATIC DIVERSITY AREAS, KEY WATERSHEDS, AND SOURCE AREAS FOR ANADROMOUS SALMONIDS IN OREGON

BASIN	STREAM	KY T1	KY T2	AFS ADA	AFS CR	SRCE	SOURCE SPECIES CO	CHF	CHS	CHM	STW	STS	CTS	COMMENTS
SILETZ	N. FK. SILETZ	1		1		1						1		
SILETZ	SAMS CR.					1	1				1		1	
SILETZ	MILL CR.					1	1				1		1	NEAR LOGSTON
YAQUINA	HAYES CR.					1	1	1			1		1	
YAQUINA	SALMON CR.					1	1	1			1		1	
YAQUINA	DEER CR.					1	1	1			1		1	
YAQUINA	THORNTON CR.					1	1	1			1		1	
YAQUINA	GRANT CR.					1		1						BELOW SAVAGE CR.
YAQUINA	WOLF CR.					1	1	1			1		1	
YAQUINA	MILL CR.	1				1				1				
YAQUINA	BUTTERMILK CR.					1	1	1			1		1	
YAQUINA	YAQUINA R. UPPER MAINSTEM					1	1	1			1		1	
ALSEA	GREEN R.					1	1				1		1	
ALSEA	CANAL CR.			1		1				1				
ALSEA	WILSON CR.					1	1				1		1	
ALSEA	CASCADE CR.					1	1				1		1	
ALSEA	TOBE CR.	1				1	1							
ALSEA	ALSEA R. ESTUARY				1									
ALSEA	CRAB CR.					1	1				1		1	
ALSEA	LOBSTER CR.	1		1		1	1				1		1	FROM JUST BELOW BEAR CR. UPSTREAM
ALSEA	DRIFT CR.	1		1		1	1				1		1	SOURCE AREA INCLUDES ENTIRE DRAINAGE
ALSEA	SCOTT CR.					1	1				1			
ALSEA	FIVE RIVER					1		1						ABOVE LORD CR.
ALSEA	ALSEA MAINSTEM					1		1	1					FALL CR. TO CONFLUENCE OF NORTH AND SOUTH FORKS
ALSEA	N.FK. ALSEA					1		1	1					MOUTH TO HIGHWAY 34
SIUSLAW	WHITTAKER CR.			1										
SIUSLAW	N. FK. SIUSLAW R. UPPER WTRSHD	1				1	1				1			ABOVE MCLEOD CR.
SIUSLAW	ESMOND CR. UPPER WTRSHD					1	1							FROM & INCLUDING LEOPOLD CR. UPSTREAM
SIUSLAW	W. FK. INDIAN CR.	1		1		1					1			SOURCE ABOVE ROGERS CR.
SIUSLAW	DOE CR.					1	1							
SIUSLAW	MCLEOD CR.			1			1							
SIUSLAW	W. FK. DEADWOOD CR.					1	1							
SIUSLAW	FISH CR.			1		1	1							
SIUSLAW	LAKE CR.					1		1						BELOW RM 17
SIUSLAW	INDIAN CR.			1										
SIUSLAW	GREENLEAF CR.			1		1	1							
SIUSLAW	SWEET CR.	1		1										
SIUSLAW	CHICAHOMINY CR. UPPER WTRSHD					1	1							ABOVE SHADY CR.
SIUSLAW	PANTHER CR.			1										
SIUSLAW	N. FK. SIUSLAW R. LOWER MAINSTEM					1		1						BELOW RM 22
SIUSLAW	KNOWLES CR.			1										
COASTAL LAKES	ROCK CR. (DEVILS LK.)					1	1							
COASTAL LAKES	BAILEY CR. (SUTTON LK.)					1	1							
COASTAL LAKES	SILTCOOS LAKE & TRIBS.			1										
COASTAL LAKES	FIDDLE CR. (SILTCOOS LK.)			1		1	1							
COASTAL LAKES	MAPLE CR. (SILTCOOS LK.)			1		1	1							
COASTAL LAKES	FIVEMILE CR. (TAHKENITCH L.)					1	1							
COASTAL LAKES	LEITEL CR. (TAHKENITCH L.)					1	1							
LOWER UMPQUA	SCHOFIELD CR.					1	1							
LOWER UMPQUA	ELK CR.					1		1			1		1	
LOWER UMPQUA	WEATHERLY CR.					1					1		1	
LOWER UMPQUA	HUBBARD CR.					1					1		1	
LOWER UMPQUA	CALAPOOYA CR.					1		1			1		1	
LOWER UMPQUA	LITTLE WOLF CR.					1	1				1		1	
LOWER UMPQUA	FRANKLIN CR.	1		1										
LOWER UMPQUA	PARADISE CR.	1				1	1				1		1	

AQUATIC DIVERSITY AREAS, KEY WATERSHEDS, AND SOURCE AREAS FOR ANADROMOUS SALMONIDS IN OREGON

BASIN	STREAM	KY TI	KY T2	AFS ADA	AFS CR	SRCE	CO	CHF	CHS	CHM	STW	STS	CTS	COMMENTS
							SOURCE SPECIES							
LOWER UMPQUA	MILL CR.			1										
SMITH	N. FK. SMITH R.	1		1										
SMITH	SMITH R. UPPER WTRSHD	1				1	1				1		1	KEY WTRSHD ABOVE RM 62; SOURCE WTRSHD=TRIBS.ABOVE RM 45.
SMITH	W. FK. SMITH R.					1	1							
SMITH	WASSEN CR.	1		1										
NORTH UMPQUA	CANTON CR.	1		1		1					1	1	1	ABOVE PASS CR.
NORTH UMPQUA	CANTON CR. CORRIDOR	1			1									MOUTH TO PASS CR.
NORTH UMPQUA	STEAMBOAT CR. CORRIDOR	1			1									MOUTH TO BIG BEND CR.
NORTH UMPQUA	STEAMBOAT CR.	1		1		1					1	1	1	ABOVE BIG BEND CR.; SOURCE=TRIBS ABOVE RM 5
NORTH UMPQUA	BIG BEND CR.	1		1		1						1	1	
NORTH UMPQUA	FISH CR.			1										
NORTH UMPQUA	CALF CR.	1		1										
NORTH UMPQUA	BOULDER CR.	1		1										
NORTH UMPQUA	HARRINGTON CR. (ROCK CR.)					1					1			
NORTH UMPQUA	E. FK. ROCK CR.					1					1			
NORTH UMPQUA	DECEPTION CR.	1												
NORTH UMPQUA	COPELAND CR.	1		1										
NORTH UMPQUA	CAVITT CR. (LITTLE R.)					1					1			UPPER FOURTH OF WATERSHED
NORTH UMPQUA	PASS CR.	1												
NORTH UMPQUA	ROCK CR.					1					1			WTRSHD INCLUDING NE. FK. ROCK CR. AND ABOVE
NORTH UMPQUA	WILSON CR.	1												
NORTH UMPQUA	N. FK. UMPQUA R. MAINSTEM	1			1	1			1					CORR=STEAMBOAT CR. TO BOULDER CR.(AFS) OR DEER CR. (KEY)
NORTH UMPQUA	LITTLE R.					1					1			ABOVE AM 21
SOUTH UMPQUA	SQUAW CR.	1		1		1					1			
SOUTH UMPQUA	S. FK. UMPQUA R. UPPER WTRSHD	1		1		1			1		1			ABOVE RM 87; CHS=MAINSTEM & JACKSON CR. STW=UPPR PARTS OF TRI
SOUTH UMPQUA	DUMONT CR.	1		1		1					1			
SOUTH UMPQUA	QUARTZ CR.	1		1		1					1			
SOUTH UMPQUA	CASTLE ROCK CR.	1		1		1					1			
SOUTH UMPQUA	JACKSON CR.	1		1		1			1		1			
SOUTH UMPQUA	BEAVER CR.	1		1		1					1			
SOUTH UMPQUA	BOULDER CR.	1		1										
SOUTH UMPQUA	BLACK ROCK CR.	1		1										
SOUTH UMPQUA	BUCKEYE CR.	1		1										
SOUTH UMPQUA	BEAVER CR.	1		1		1					1			
SOUTH UMPQUA	JACKSON CR.	1			1	1			1					MOUTH TO FALCON CR.
SOUTH UMPQUA	WINDY CR. (COW CR.)					1	1	1			1		1	UPPER ONE THIRD OF BASIN
SOUTH UMPQUA	W. FK. COW CR.	1				1	1	1			1		1	WATERSHED INCLUDING BEAR CR. AND ABOVE
SOUTH UMPQUA	UNION CR. (COW CR.)					1	1	1			1		1	UPPER HALF OF BASIN
SOUTH UMPQUA	RIFFLE CR. (COW CR.)					1	1	1			1		1	WATERSHED INCLUDING BONNIE CR. AND ABOVE
SOUTH UMPQUA	QUINES CR. (COW CR.)					1	1				1		1	UPPER HALF OF BASIN
SOUTH UMPQUA	MIDDLE CR. (COW CR.)	1				1	1				1		1	SOURCE WTRSHD ABOVE FORKS
SOUTH UMPQUA	DOE CR. (COW CR.)					1	1				1		1	WATERSHED INCLUDING COOKHOUSE CR. AND ABOVE
SOUTH UMPQUA	S. FK. UMPQUA R. CORRIDOR	1			1	1			1					COW CR. TO RM 87; CHS SOURCE AREA=RM 75-87
TENMILE LAKES	TENMILE LAKE			1										
TENMILE LAKES	TENMILE CR.			1										
TENMILE LAKES	JOHNSON CR. (10 MI. LK.)			1		1	1				1			
TENMILE LAKES	BIG CR. (10 MI. LK.)			1		1	1				1			
COOS	E. FK. MILLICOMA R.				1	1		1						
COOS	S. FK. COOS R.				1									
COOS	TIOGA CR.	1			1	1	1	1			1			INCLUDED IN S. FK. COOS R. CORRIDOR
COOS														

AQUATIC DIVERSITY AREAS, KEY WATERSHEDS, AND SOURCE AREAS FOR ANADROMOUS SALMONIDS IN OREGON

BASIN	STREAM	KY T1	KY T2	AFS	ADA	AFS CR SRCE	SOURCE SPECIES CO	CHF	CHS	CHM	STW	STS	CTS	COMMENTS
COQUILLE	ROCK CR.					1	1				1			
COQUILLE	N. FK. COQUILLE R.			1		1	1				1			ABOVE THE LITTLE NORTH FORK
COQUILLE	S. FK. COQUILLE R. LWR MAINSTEM					1		1						MOUTH TO RM 35.5
COQUILLE	S. FK. COQUILLE R. UPPER WTRSHD	1		1		1		1					1	ABOVE RM 35.5; SOURCES: CT IN EDEN VALLEY; CHF BELOW FALLS
COQUILLE	STEEL CR.					1	1				1			
COQUILLE	MIDDLE CR.					1	1				1			
COQUILLE	SALMON CR.	1		1										
ELK/SIXES	SIXES R. & EST.				1									BELOW DRY CR.
ELK/SIXES	DRY CR.	1		1		1		1						
ELK/SIXES	SIXES R. UPPER WTRSHD			1										ABOVE RM 29
ELK/SIXES	ELK R. UPPER WTRSHD	1		1		1		1						SOURCE ABOVE BALD MTN CR.
ELK/SIXES	ELK R. CORRIDOR				1									MOUTH TO RM 10
ROGUE BELOW GOLD RAY	N. FK. LOBSTER CR.			1										
ROGUE BELOW GOLD RAY	W. FK. EVANS CR.					1	1				1	1		RM 0-13
ROGUE BELOW GOLD RAY	LOBSTER CR.				1									
ROGUE BELOW GOLD RAY	E. FK. EVANS CR.					1	1				1	1		RM 0-12
ROGUE BELOW GOLD RAY	QUOSATANA CR.	1		1										
ROGUE BELOW GOLD RAY	TAYLOR CR.	1												
ROGUE BELOW GOLD RAY	ROGUE R. UPPER CORRIDOR				1									EVANS C. TO GOLD RAY DAM
ROGUE BELOW GOLD RAY	FOOTS CR.			1		1					1	1		
ROGUE BELOW GOLD RAY	KANE CR.			1		1					1	1		
ROGUE BELOW GOLD RAY	GALLS CR.			1		1					1	1		
ROGUE BELOW GOLD RAY	ROGUE R. LOWER CORRIDOR				1									ILLINOIS R. - GRAVE CR.
ROGUE BELOW GOLD RAY	SUCKER CR. UPPER WTRSHD	1		1										ABOVE RM 11, INCLUDES GRAYBACK & CAVE CR.
ROGUE BELOW GOLD RAY	SARDINE CR.			1		1					1	1		
ROGUE BELOW GOLD RAY	S. FK. LOBSTER CR.			1										
ROGUE BELOW GOLD RAY														
ROGUE BELOW GOLD RAY														
ROGUE BELOW GOLD RAY														
ROGUE BELOW GOLD RAY														
ROGUE BELOW GOLD RAY														
ROGUE BELOW GOLD RAY	[illegible] (ILLINOIS R.)			1							1			
ROGUE BELOW GOLD RAY	SUCKER CR. (ILLINOIS R.)				1	1	1				1			SOURCE ABOVE CHINA GARDENS (RM 15)
ROGUE BELOW GOLD RAY	W. FK. ILLINOIS R.				1									MOUTH TO ELK CR.
ROGUE BELOW GOLD RAY	ILLINOIS R. CORRIDOR				1									
ROGUE BELOW GOLD RAY	SIXMILE CR. (ILLINOIS R.)			1										
ROGUE BELOW GOLD RAY	WOOD CR. (ILLINOIS R.)			1										
ROGUE BELOW GOLD RAY	E. FK. ILLINOIS R.	1		1										ABOVE RM 8
ROGUE BELOW GOLD RAY	ROUGH & READY CR. (ILLINOIS R.)			1										
ROGUE BELOW GOLD RAY	SILVER CR. (ILLINOIS R.)	1		1										

AQUATIC DIVERSITY AREAS, KEY WATERSHEDS, AND SOURCE AREAS FOR ANADROMOUS SALMONIDS IN OREGON

BASIN	STREAM	KY T1	KY T2	AFS ADA	AFS CR	SRCE	CO	CHF	CHS	CHM	STW	STS	CTS	COMMENTS
							SOURCE SPECIES							
ROGUE ABOVE GOLD RAY	S. FK. L. BUTTE CR. CORRIDOR	1			1	1	1				1	1		
S COAST SM OCEAN TRIBS	WINCHUCK R. & EST. CORRIDOR				1									BELOW E. FK
SANTIAM/CALAPOOIA	CANYON CR. (S. FK. SANTIAM R.)				1	1					1			

AQUATIC DIVERSITY AREAS, KEY WATERSHEDS, AND SOURCE AREAS FOR ANADROMOUS SALMONIDS IN OREGON

BASIN	STREAM	KY T1	KY T2	AFS AD	AFS CR	SRCE	SOURCE SPECIES CO	CHF	CHS	CHM	STW	STS	CTS	COMMENTS
WESTSIDE WILLAMETTE TRIB	N. FK. YAMHILL R.					1					1			ABOVE TURNER CR.
MCKENZIE	LOOKOUT CR.	1		1										
MCKENZIE	ANDERSON CR.			1										
MCKENZIE	GATE CR.					1			1					
MCKENZIE	MCKENZIE R. UPPER WTRSHD	1		1										ABOVE BELKNAP HOT SPRINGS
MCKENZIE	MCKENZIE R. CORRIDOR	1			1	1			1					SOURCE ABOVE GATE CR; CORRIDOR ABOVE BLUE R.
MCKENZIE	DEER CR.	1		1										
MCKENZIE	BEAR CR.	1		1										
MCKENZIE	MARTIN CR.	1		1										
MCKENZIE	SEPARATION CR.	1		1		1			1					
MCKENZIE	HORSE CR.	1		1	1	1			1					CORRIDOR BELOW SEPARATION CR.
MCKENZIE	SCOTT CR.	1		1										
M. FK. WILLAMETTE	LITTLE FALL CR.					1					1			
M. FK. WILLAMETTE	M. FK. WILLAMETTE R.				1	1			1					AFS CORRIDOR NEAR LOWELL FOR OREGON CHUB
SANDY	CLEAR CR.					1					1			
SANDY	CAMP CR.					1					1			
SANDY	CLEAR FK.					1					1			
SANDY	LOST CR.					1					1			
SANDY	BULL RUN R.		1											
SANDY	SANDY R. UPPER MAINSTEM					1			1					MAINSTEM BETWEEN MARMOT DAM & MUDDY FK.
SANDY	STILL CR.					1					1			
SANDY	SALMON R.	1		1		1					1			ABOVE RM 7
SANDY	SANDY R. LOWER MAINSTEM					1		1						MAINSTEM BELOW MARMOT DAM
HOOD/FIFTEENMILE	HOOD R. MAINSTEM					1		1	1					CHF: MOUTH TO RM4; STW: MOUTH TO RMI2.
HOOD/FIFTEENMILE	W. FK. HOOD R.					1			1			1		CHS: RM8-13; STS: RM4-13.
HOOD/FIFTEENMILE	LAKE BRANCH (W. FK. HOOD R.)					1						1		MOUTH TO RM5.
HOOD/FIFTEENMILE	GREEN POINT CR. (W. FK. HOOD R.)					1					1			MOUTH TO RM3.
HOOD/FIFTEENMILE	McGEE CR. (W. FK. HOOD R.)					1			1					MOUTH TO RM1.
HOOD/FIFTEENMILE	ELK CR. (W. FK. HOOD R.)					1			1					MOUTH TO RM2.
HOOD/FIFTEENMILE	COE BRANCH (CLEAR BRANCH)			1										
HOOD/FIFTEENMILE	CLEAR BRANCH (M. FK. HOOD R.)			1										
HOOD/FIFTEENMILE	ELIOT BRANCH (M. FK. HOOD R.)			1										
HOOD/FIFTEENMILE	M. FK. HOOD R. CORRIDOR				1									MOUTH TO ELIOT BRANCH
HOOD/FIFTEENMILE	E. FK. HOOD R.					1					1			MOUTH TO RM10.
HOOD/FIFTEENMILE	S. FK. MILL CR.			1										
HOOD/FIFTEENMILE	MILL CR. CORRIDOR				1	1					1			MOUTH TO FORKS (RM8).
HOOD/FIFTEENMILE	N. FK. MILL CR.			1										
HOOD/FIFTEENMILE	EIGHTMILE CR. (FIFTEENMILE CR.)			1		1			1					ADA ABOVE RM 7; STW: RM10-25.
HOOD/FIFTEENMILE	RAMSEY CR. (FIFTEENMILE CR.)			1		1					1			STW: MOUTH TO RM6.
HOOD/FIFTEENMILE	FIFTEENMILE CR.			1		1					1			ADA ABOVE RM 31; STW: RM30-45.
HOOD/FIFTEENMILE	FIFTEENMILE CR. CORRIDOR				1									MOUTH TO RM 31
HOOD/FIFTEENMILE	EIGHTMILE CR. CORRIDOR				1									MOUTH TO RM 7
LOWER DESCHUTES	SHITIKE CR.			1		1		1	1					CHS: RM5-30; STS: MOUTH TO RI M 30.
LOWER DESCHUTES	WARM SPRINGS R.			1		1			1			1		CHS: RM10-44; STS: RM10-48.
LOWER DESCHUTES	DESCHUTES R MAINSTEM					1		1				1		CHF: LOWER 100 MILES; STS: RM45-100
						1						1		MOUTH TO DODD'
						1						1		RM 30 TO RM 36
						1						1		MOUTH TO RM 10
						1						1		MOUTH TO RM 13
				1		1						1		SOURCE AREA AB

AQUATIC DIVERSITY AREAS, KEY WATERSHEDS, AND SOURCE AREAS FOR ANADROMOUS SALMONIDS IN OREGON

BASIN	STREAM	KY T1	KY T2	AFS AD	AFS CR	SRCE	SOURCE SPECIES CO	CHF	CHS	CHM	STW	STS	CTS	COMMENTS
NORTH JOHN DAY	N. FK. JOHN DAY R.			1		1			1					ABOVE RM 72.5; SOURCE TO RM 101 & LOWER REACHES OF TRIBS.
NORTH JOHN DAY	WALL CR.					1						1		MOUTH TO WILLOW SPRING CR.
NORTH JOHN DAY	CAMP CR. (M. FK. JOHN DAY)					1						1		LICK CR. TO EAGLE CR., INCLUDING LICK CR.
NORTH JOHN DAY	CAMAS CR. CORRIDOR				1									RM 10 TO RM 21
NORTH JOHN DAY	CAMAS CR.			1										ABOVE RM 21
NORTH JOHN DAY	FIVEMILE CR.			1										
NORTH JOHN DAY	CLEAR CR.			1										
NORTH JOHN DAY	N. FK. JOHN DAY CORRIDOR				1	1			1					RM 60 TO RM 72.5; SOURCE INCLUDES LOWER REACHES OF TRIBS.
NORTH JOHN DAY	S. FK. CABLE CR. (CAMAS CR.)			1		1						1		
NORTH JOHN DAY	DESOLATION CR. CORRIDOR				1	1						1		MOUTH TO RM 20; SOURCE AREA ABOVE RM 13
NORTH JOHN DAY	OLIVE CR. (CLEAR CR.)					1						1		INCLUDING BEAVER CR.
NORTH JOHN DAY	BIG CR.			1										
NORTH JOHN DAY	M. FK. JOHN DAY CORRIDOR				1	1			1					RM 46 TO RM 67; SOURCE RM 46- 71 & LOWER REACHES OF TRIBS.
NORTH JOHN DAY	WILSON CR.					1						1		MOUTH TO RM 5
NORTH JOHN DAY	GRANITE BOULDER CR.			1										
NORTH JOHN DAY	HIDAWAY CR.			1										IN THE VICINITY OF HIDAWAY MEADOWS
NORTH JOHN DAY	GRANITE CR.			1		1			1					SOURCE AREA: BULL RUN CR. DOWNSTREAM, INCLUDING CLEAR CR.
NORTH JOHN DAY	CABLE CR. (CAMAS CR.)					1						1		
NORTH JOHN DAY	FOX CR. (COTTONWOOD CR.)					1								RM 11 TO RM 17
NORTH JOHN DAY	DESOLATION CR.			1		1						1		ABOVE RM 20
NORTH JOHN DAY	LOST CR.			1										
NORTH JOHN DAY	LONG CR. (M. FK. JOHN DAY)					1						1		RM 19 TO RM 30
UPPER JOHN DAY	COTTONWOOD CR.			1		1						1		SOURCE AREA ABOVE E, FK.; ADA BEGINS 1 MILE ABOVE DYKE CR.
UPPER JOHN DAY	CALL CR.			1										
UPPER JOHN DAY	RAIL CR.			1										
UPPER JOHN DAY	FIELDS CR.			1										
UPPER JOHN DAY	JOHN DAY R. CORRIDOR				1									DIXIE CR. TO REYNOLDS CR.
UPPER JOHN DAY	LAYCOCK CR.			1										
UPPER JOHN DAY	DEARDORF CR.			1										
UPPER JOHN DAY	JOHN DAY R. (UPPER)			1		1			1					ABOVE REYNOLDS CR.; SOURCE RM263-277 & LOWER REACHES OF TRIB
UPPER JOHN DAY	E. [illegible]													
UPPER JOHN DAY	CANYON													
UPPER JOHN DAY	REYNOLD[illegible]													
UPPER JOHN DAY	McCLELLAN CR.			1										
UPPER JOHN DAY	ROBERTS CR.			1										
UPPER JOHN DAY	MOON CF													
UPPER JOHN DAY	BEECH C													
UMATILLA	SQUAW C													
UMATILLA	E.													

AQUATIC DIVERSITY AREAS, KEY WATERSHEDS, AND SOURCE AREAS FOR ANADROMOUS SALMONIDS IN OREGON

BASIN	STREAM	KY T1	KY T7	AFS AD	AFS CR	SRCE	SOURCE SPECIES CO	CHF	CHS	CHM	STW	STS	CTS	COMMENTS
WALLA WALLA	S. FK. WALLA WALLA R.			1		1								
LOWER GRANDE RONDE	WENAHA R.			1		1			1			1		SOURCE AREA BELOW FORKS & IN STREAMS LISTED SEPARATELY
LOWER GRANDE RONDE	N. FK. WENAHA R.			1		1						1		
LOWER GRANDE RONDE	MILK CR. (W... R.			1		1						1		
LOWER GRANDE RONDE	LITTLE MINAM R.			1		1			1					MOUTH TO A.5
LOWER GRANDE RONDE	COUGAR CR. (JOSEPH CR.)			1										
LOWER GRANDE RONDE	BROADY CR. (COTTONWOOD CR.)			1		1						1		
LOWER GRANDE RONDE	BIG PEAVINE CR.			1										
LOWER GRANDE RONDE	DEER CR. (WALLOWA R.)					1						1		
LOWER GRANDE RONDE	LITTLE PEAVINE/RUSH CR.			1										
LOWER GRANDE RONDE	CHESNIMNUS CR. (UPPER)			1										ABOVE DEVILS RUN CR.
LOWER GRANDE RONDE	WALLOWA R. CORRIDOR				1									MOUTH TO HURRICANE CR.
LOWER GRANDE RONDE	BEAR CR. CORRIDOR (WALLOWA R.)				1									MOUTH TO L. BEAR CR.
LOWER GRANDE RONDE	GRANDE RONDE R. CORRIDOR				1									MOUTH TO MINAM R.
UPPER GRANDE RONDE	PHILLIPS CR.					1						1		RM5-10.
UPPER GRANDE RONDE	E. FK. PHILLIPS CR.					1						1		LOWER 1 MILE.
UPPER GRANDE RONDE	FIVE POINT CR.			1		1						1		
UPPER GRANDE RONDE	LIMBER JIM CR.			1		1						1		
UPPER GRANDE RONDE	BEAVER CR.			1										
UPPER GRANDE RONDE	CLEAR CR.			1										
UPPER GRANDE RONDE	N. FK. CATHERINE CR.			1		1			1			1		
UPPER GRANDE RONDE	CHICKEN/INDIANA CR.			1										
IDE	GRANDE RONDE R. (TIUPPERGRANDE	RONDE		LITTLE	CATHERINE CR.									
						1						1		MOUTH TO RM5.
UPPER GRANDE RONDE	CATHERINE CR.					1		1	1		CHS:	RM25-32.5;		STS: TOWN OF UNION UPSTREAM.
UPPER GRANDE RONCE	S. FK. CATHERINE CR.													
IMNAHA	COW CR.			1										
IMNAHA	LIGHTNIN_ CR.			1										
IMNAHA	GROUSE CR.					1						1		
IMNAHA	IMNAHA R. (UPPER)			1		1			1			1		ABOVE GROUSE CR.
IMNAHA	BIG SHEEP CR.			1		1						1		
IMNAHA	LICK CR.			1		1						1		
IMNAHA	CAMP CR.					1						1		
IMNAHA	IMNAHA R. CORRIDOR				1	1			1			1		MOUTH TO GROUSE CR.
IMNAHA	HORSE CR.			1		1						1		

KEY:

KY T1 -	FEMAT Tier 1 Key Watershed
KY T2 -	FEMAT Tier 2 Key Watershed
AFS AFDA -	Oregon Chapter American Fisheries Society Aquatic Diversity Area
AFS CR -	Oregon Chapter American Fisheries Society Critical Corridor
SRCE -	Source
CO -	Coho
CHF -	Spring Chinook
CHM -	Chum
STW -	Winter Steelhead
STS -	Summer Steelhead
CTS -	Sea run Cutthroat

	3			4			5		
NO.	RANK	THIRD	NO.	RANK	THIRD	NO.	RANK	THIRD	
13+	1	3	4	9	1	4	1	3	10
			45	1	3	4	1	3	14
			18	3	3	3	2	2	13
			14	5	2	3	2	2	11
			22	2	3	3	2	2	9
1	9	1	5	8	1	3	2	2	8
5	7	1	6	7	1	3	2	2	10

TABLE 3. Continued...									
	GEOGRAPHIC AREA, BASIN, OR WATERSHED	B. IMPACT/RISK			C. OPTIMISM/ POTENTIAL			TOTAL	NOTES
		1	2	3	1	2			
1	*Nehalem*	*High*		*1*	*1.8*	*2.2*			*See Text*
2	*Tillamook*	*Moderate*		*2*	*1.8*	*1.7*			
3	*Nestucca*	*Moderate*		*2*	*1.6*	*1.6*			
4	*Alsea*	*High*		*3*	*1.6*	*1.8*			
5									
6									
7									

REFERENCES

Nehlsen, W., J.E. Williams, and J. A. Lichatowich. 1991. Pacific'salmon at the crossroads: Stocks at risk from California, Oregon, Idaho and Washington. Fisheries 16(2):4-2 1.

Nicholas, J.W. 1993. Relative ranking of salmon and steelhead populations in Oregon Coastal Basins: a proposed system to permit informed choice-making in fishery resource management, with emphasis on assigning restoration priorities. Oregon Department of Fish and Wildlife, Corvallis, Oregon.

Oregon Division of State Lands (DSL) 1994. Stage 1 watershed assessment: final report. December 19, 1994.

SECTION III.
PRIORITIZING PROTECTION AND RESTORATION ACTIVITIES WITHIN WATERSHEDS

PART 1.
PROCEDURE FOR PRIORITIZING PROTECTION AND RESTORATION ACTIVITIES WITHIN WATERSHEDS

This section provides a framework for identifying high-priority protection and restoration activities within specific watersheds. It is intended to provide a common basis from which diverse interests, such as those represented in watershed councils, can develop mutually agreed-upon restoration priorities. In most cases a watershed will contain both federal and non-federal lands; as discussed in Part I, Section 2, federal guidelines for conducting watershed analyses are in effect for such lands. The process contained in this section provides an integrating framework for prioritizing protection and restoration activities across diverse land ownerships within a watershed.

Prioritizing protection and restoration within a watershed should be done by a watershed team familiar with the local watershed conditions. Such a watershed team may use this handbook to establish priorities for those who wish to propose restoration projects, and then review proposals in the context of these priorities. Alternatively, project proposers themselves may wish to create a watershed team and use this prioritization process to justify their proposals; proposals then would be evaluated on the basis of how credibly the proposers carried out the prioritization process.

To be most effective, a watershed team should include technically-competent individuals representing several scientific disciplines, including geology, biology/ecology, and hydrology. A key element is the capability to understand the physical and biological roles of tributaries and their fish populations in the larger watershed unit. Knowledge of the history of the watershed and land and water use is critical, as is a good understanding of current conditions and ongoing protection and restoration efforts. Take advantage of local knowledge.

To carry out the following steps, several types of data will be needed. Maps that depict the watershed at a fine scale are extremely helpful, including maps depicting the topography of the watershed (such as the USGS quad maps); maps of current land use, including forest age classes, other vegetation features, and riparian areas; and historical maps that help infer past land use and riparian habitat conditions.

In addition, any sources of data that help define the past and present character of the watershed, particularly streamside vegetation, the river channel, and key biological components (such as fish, beaver, and aquatic invertebrates) should be considered. The watershed team will need to pull together qualitative and quantitative data from many sources, evaluate the appropriateness and reliability of the data, and, to the extent possible, infer the responses necessary to complete the checklist.

Proposed or approved restoration projects should be a logical outcome of the process outlined herein. If restoration projects are proposed that are not the result of the train of logic discussed below, clear explanations should be provided. Projects that are not consistent with this process may be justified if there are unique circumstances, they are to be conducted on an experimental basis, or specific finding sources or volunteer interest call for them.

STEP 1. RESPOND TO THE CHECKLIST FOR PROPOSERS AND REVIEWERS OF PROPOSED WATERSHED RESTORATION PROJECTS.

The following checklist is designed to help the watershed team understand how a watershed functions and how this function affects aquatic biodiversity, both today and historically. The purpose of the checklist is to provide a common set of guidelines leading to a reasonable train of logic that connects proposed restoration projects to watershed processes and thereby optimizes biological benefits.

Responses to the questions in the checklist need not be more than a few paragraphs, and they may be largely qualitative. However, responses should be as detailed as necessary to provide a reasonable basis for project identification and selection. Projects for which information is available to answer the questions fully and specifically are more likely to succeed than projects that do not. (If qualitative or quantitative information is not sufficient to answer most of the questions in the checklist, the user is asked to proceed to Step 3.)

CHECKLIST FOR PROPOSERS AND REVIEWERS OF PROPOSED WATERSHED RESTORATION PROJECTS

Pre-Development Condition

1. What was the nature of the watershed prior to any influences by Euro-Americans? Emphasize the character of aquatic/riparian habitats: streamside vegetation, the channel, and key biological components (for example, fish, beaver, aquatic invertebrate populations).

2. What are the watershed processes that likely created and maintained aquatic/riparian habitats prior to Euro-American settlement? (Such processes include functional linkages among the land forms, physical processes and biological factors; spatial linkages among landscape components; natural disturbance regimes dominating different components of the landscape, such as landslides, fire, drought and flood.) How often, how extensive, and what types of disturbances occurred?

Historical Changes in Watershed Conditions

3. What historical changes in watershed or aquatic/riparian habitat conditions have occurred since pre-Euro-American settlement times?

4. How have these changes affected aquatic/riparian habitats and key biological components?

5. How have these changes likely affected the watershed processes that create and maintain aquatic/riparian habitats?

Current Conditions

6. What are the current conditions of the watershed, aquatic/riparian habitats and key biological elements?

7. A. What are the watershed processes that presently create and maintain aquatic/riparian habitats? Give specific examples.

   B. What are the biological processes that maintain biological elements?

8. A. Where are the areas of good aquatic/riparian habitat? What parts of the watershed influence the areas of good aquatic/riparian habitat?

   B. What are the areas of good biological status? What supports these areas?

9. A. What are the hazards within the watershed that threaten the areas of good aquatic/riparian habitats?

   B. What hazards within and outside the watershed threaten biological elements and processes?

Probable Trends

10. What type of protection is needed for areas of good aquatic/riparian habitat, good biological condition, and places influencing such areas? Has this protection been implemented? If not, will it be implemented before or in conjunction with the proposed project?

11. Are the activities that contributed to the current aquatic/riparian and biological conditions (if degraded from pre-Euro-American settlement times) still occurring? What types of protection are needed to reduce or prevent hazards that may be threats to aquatic/riparian systems?

12. How will current conditions be affected by natural disturbance events such as landslides, drought, flood or fire? Will the normal effects of natural disturbances likely be exacerbated by past human activities? (For example, will floods be larger or will there be more frequent and intense landslides?) Will current conditions of aquatic/riparian and biological systems become worse without human intervention? What specific areas in the watershed are likely to respond badly to such natural disturbance events, creating further degradation in aquatic/riparian and biological systems?

Desired Future Conditions and Restoration

13. What are the desired future conditions for aquatic/riparian habitats and key biological components (such as fish populations)? How do these desired future conditions relate to

the pre-development conditions? Over what time period can the desired future conditions be achieved?

14. What land use changes, management activities, or restoration techniques will help achieve the desired future conditions? How will they affect the watershed and biological processes that create and maintain aquatic/riparian habitats and biotic conditions, including natural disturbances? Will they address specific areas in the watershed that are likely to respond badly to natural disturbances?

Monitoring and Evaluation

15. What reference sites or reference conditions provide examples of relatively undisturbed aquatic/riparian ecosystems and key biological components, and/or the desired future conditions? How do these reference conditions compare with the pre-development condition? What success indicators and benchmarks will indicate progress toward achieving desired future conditions?

16. What long-term (15-20+ years) monitoring and evaluation strategies at a regional scale (including appropriate sampling design, monitoring techniques, indicators of success, data base management, and reporting) have been identified in each region?

STEP 2. BASED ON THE RESPONSES TO THE CHECKLIST, IDENTIFY A WATERSHED RESTORATION STRATEGY OR PROJECTS USING THE FOLLOWING PRIORITIES.

The objective of restoration is to return a watershed from a deteriorating condition to a recovering condition, and ultimately to a condition similar to that prior to perturbation. The reference condition (estimated through historical information or present-day reference sites) provides the template for conditions prior to perturbation. If simply stopping the degradation will allow a watershed to recover on its own, it should be allowed to do so; this is the most effective and inexpensive strategy. If the evaluation determines that a watershed cannot recover naturally once degradation has been halted or cannot recover quickly enough, proposed restoration projects should help return it to conditions characterized by rates and patterns of ecosystem processes and elements that sustain native fishes at desired levels.

Priorities for watershed restoration:

1. First, remove or stop the human-caused perturbations that are degrading aquatic habitats and biological conditions.

2. Then, allow the watershed time to recover naturally.

3. If the watershed cannot recover or recover quickly enough naturally, identify restoration activities that will help return it to conditions characterized by rates and patterns of ecosystem processes and elements that sustain native fishes at desired levels. Restoration projects should be aimed at moving the rates and patterns of ecosystem processes and elements toward reference conditions. Projects should look natural from a structural standpoint and perform functions that represent the functions of the reference condition. Nonnative materials, except cabling, should not be used, and only native plant and animal species should be used.

Programs and projects that result from carrying out the checklist and that adhere to these priorities should receive strong consideration for funding. If there is too little information to carry out Steps 1 and 2, the more conservative approach identified in Step 3 should be followed.

STEP 3. IF INFORMATION IS NOT ADEQUATE TO IDENTIFY OR REVIEW RESTORATION PROJECTS BASED ON STEPS 1 AND 2, USE THE FOLLOWING PRIORITIES.

When there is lack of information about a watershed, a restoration strategy that is likely to be effective across wide geographic areas and in a range of states of disrepair should be used. The strategy most likely to be effective is to treat and reduce physical hazards to upslope areas that threaten the future health of the watershed (such as potential landslides), and to allow the riparian ecosystem to recover by stopping the damaging effects of activities such as grazing, timber harvest, road building and intense recreational use. At a minimum, this strategy will reduce the likelihood that major disturbances, such as floods and fires, will exacerbate human impacts in a watershed and promote further ecosystem degradation. It will do no harm, and likely will be effective in helping a watershed return to conditions characterized by ecosystem processes and elements that sustain native fishes. In addition, in the face of limited information it may make sense to redouble protection efforts rather than pursuing restoration. At the same time, efforts should be made to gain an understanding of ecosystem processes and elements so that a more targetted restoration strategy can be developed.

Treat and reduce upslope hazards. This primarily means treating road conditions that potentially lead to mass land failures, excessive gully erosion and chronic sedimentation. (See discussion below for additional guidance on treating and reducing upslope hazards.)

Allow the riparian ecosystem to recover by stopping negative impacts from damaging activities. The first step in restoring riparian vegetation is to remove the human impacts that cause degradation, such as abusive livestock grazing, logging in riparian zones, agricultural activities at the streambank edge, and road construction. The objective of riparian ecosystem recovery is to re-establish functional and structural attributes of riparian vegetation. This means that riparian vegetation serves as a source of leaf and other organic litter, provides shading and temperature moderation, promotes bank stability, and is a source of large woody debris.

Redouble protection efforts. Where information on ecosystem processes and elements is lacking, it may make more sense to put available resources into additional or broader protection than to pursue restoration. Of particular importance is establishing protection against depleted instream flows, non-native plant and animal introductions, toxic chemicals, and structural modifications such as filling, diking, channelizing etc.

Consider other types of activities only if: They are legitimate experiments based on an analysis of reference conditions, including monitoring based on using a reference stream as a control; or if funds or volunteer resources are available only for specific activities other than those described above. Where ecosystem processes and elements are poorly understood, there is great potential for doing more harm than good. Therefore, a conservative approach to restoration should be taken.

PART 2.
TREATING AND REDUCING UPSLOPE HAZARDS

Sources of Erosion and Sediment Yield

In steep forested lands managed for timber, there are a few basic sources of human-caused erosion and sediment yield that have been identified as common and potentially important (depending on the watershed) to anadromous fish. There are only a limited number of these sediment sources that can be treated cost-effectively.

Soil movement originating from roads is the most easily treated sediment source. Cost-effective treatments are available to prevent and control these sources:

1. Stream crossing failures
2. Stream diversions at stream crossings
3. Road fill slope failures
4. Debris torrents from roads built across steep slopes or swales
5. Landing fill failures
6. Erosion of fine sediment from road surfaces, cutbanks and ditches.

In contrast, sediment which originates from land sliding on harvested hillslopes or on steep stream-side slopes is usually difficult or impossible to effectively control. The most effective technique is to prevent these human-caused sediment sources by avoiding timber harvest on potentially unstable slopes and avoiding disruptive land uses that trigger soil movement. Regardless of source of sediment, prevention is almost always the cheapest treatment for human-caused erosion and sediment yield, and in many cases it may be the only cost-effective solution.

Sediment Delivery

Not all soil erosion and land sliding in a watershed is harmful to the aquatic system. Although some erosion occurs naturally, many watersheds now experience rates of soil erosion that are greatly increased over those of undisturbed landscapes. Of this increased erosion, only that sediment which reaches a stream channel, and is then transported downstream to fish-bearing reaches, will adversely impact aquatic habitat. Thus, the amount of this sediment actually delivered to a stream channel becomes more important than the total amount which may have eroded or failed. This delivered volume is called sediment yield.

All sediment which enters a stream, regardless of its volume or the size of the watercourse, will eventually be transported downstream and thereby affect channels with Salmonid habitat. For this reason, recommended erosion prevention treatments are generally prescribed only for sites with a potential for future sediment yield. These are the only sites deemed capable of delivering sediment to downstream fish-bearing stream channels.

Different erosional processes' have different rates of sediment delivery or yield to the stream system. Some eroded sediment never reaches stream channels, and these sites become low priority for treatment. Many road cutbank failures and fill slope failures, where soil is deposited on the road bench or a naturally low gradient slope without entering a stream, fall into this category. Other processes deliver only a small portion of the failed or eroded sediment to a channel. Many hillslope landslides and slope failures along roads and landings fall into this category. Finally, some processes deliver a large proportion (up to 100%) of the eroded sediment directly to streams. These include eroded stream crossings (for example, where a culvert plugs and the stream gullies through the road fill), as well as gullies that develop when a stream is diverted out of its channel and down the adjacent road or hillslope.

Decommissioning Roads to Control Sediment

A variety of treatments can be applied to prevent erosion and sediment yield to stream channels from roads. These include erosion-proofing along roads and landings, road upgrading, and full road decommissioning. All roads in highly productive watersheds and sub-basins should be considered for either decommissioning or upgrading, depending upon the risk of their impacting the aquatic system. General techniques for decommissioning are well documented and tested, and costs and procedures are well established.

In priority watersheds, efforts should be made to delineate which roads pose high risk of accelerated or chronic sediment production and delivery, or high long term maintenance costs, and which might be excellent candidates for decommissioning (proper "hydrologic closure"). Based on potential threats to the aquatic system, a variety of roads qualify as best candidates for decommissioning. These include roads built in riparian zones, roads with a high potential risk of sediment production (such as those built on steep inner gorge slopes and those built across unstable or highly erodible soils), roads built in tributary canyons where stream crossings and steep slopes are common, roads which have high maintenance costs and requirements, and abandoned roads.

Not all roads are high risk roads and those that pose a low risk of impacting aquatic habitat in the basin may not need immediate attention. Roads which are of low relative priority for decommissioning include those which follow low gradient ridges, roads traversing large benches or low gradient upland slopes, and roads with few or no stream crossings.

Treatment Cast-Effectiveness

Requiring proposed restoration projects to meet pre-established cost-effectiveness criteria is critical to developing a defensible and objective watershed protection and restoration plan. For sediment control, the cost-effectiveness of treating a work site can be defined as the average amount of money spent to prevent one cubic yard of sediment from entering or being delivered to the stream system ($/yd3). By using this evaluation methodology a variety of different techniques and proposed projects can be compared against each other using the same criteria: reducing the greatest amount of accelerated sediment yield for the least expenditure possible.

The most cost-effective projects are those which prevent erosion and sediment yield, rather than those which try to control erosion once it has begun. Perhaps the most cost-effective tool for minimizing future erosion and sediment delivery to fish-bearing streams is the use of preventive land use practices that limit the amount and location of watershed disturbances. Next, projects that prevent erosion from existing disturbed areas (such as roads) through physical excavation, removal or upgrading are often relatively cost-effective. Projects which are least cost-effective are generally those which require relatively large amounts of hand labor, those that attempt to control ongoing erosion, and those that are designed to treat relatively small sediment sources.

Cost-effectiveness can be used as a tool to prioritize potential treatment sites throughout a sub-basin. It assures that the greatest benefit is received for the limited funding that is typically available for protection and restoration projects. The sites selected for eventual treatment are the ones that are expected to generate the most cost-effective reduction in sediment delivery to the drainage network and the mainstem channel. Estimating the cost-effectiveness of such projects will also help identify which roads in the basin are truly the best targets for decommissioning.

When Does It Make Sense to Move to Another Watershed?

Watershed assessments and erosion inventories describe and document the expected magnitude of future, preventable erosion and sediment yield, especially from roads and other treatable sediment sources. Not all these future threats are of the same magnitude or importance, and not all have to be treated at once to provide adequate protection from short-term, catastrophic loss.

In basins that are to be managed primarily for fisheries recovery and protection, a discrete list of prioritized erosion prevention and restoration projects can be implemented to limit the threat of future human-caused erosion and sediment yield. High priority, cost-effective erosion prevention sites should be treated quickly in each high priority basin to protect valuable habitat from preventable storm damage or loss. High and moderate risk roads can be decommissioned and a bare-bones network of low impact roads can serve for monitoring and administrative management of the basin's aquatic resources.

As a general rule-of-thumb, erosion prevention treatments which can be performed for less than $10/yd^3 are considered relatively cost-effective. In most sub-watersheds, there will often be projects that are not considered cost-effective, compared to needed restoration and protection work that could have been done in other priority watersheds. Once initial, cost-effective measures have been undertaken to protect these basins from the threat of catastrophic habitat loss, the remaining prevention, protection and restoration measures that are needed to encourage long term recovery can then be implemented.

In large part, restoration and protection work in a priority watershed will probably never be completed if that watershed is also to be subjected to continued land management. High risk roads can be decommissioned and "storm-proofed" to provide for immediate protection against loss, but proposed land management will require continual review and analysis to assure that the aquatic system is adequately restored and protected from the effects of past and future land use activities.